

SDS 92 COMPUTER- CONTROLLED SYSTEMS



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1. INTRODUCTION

The high-performance characteristics of the SDS 92 computer and its low cost provide a uniquely qualified machine to perform central controlling functions in applications such as direct digital control, message switching, data collection, formatting, and analysis.

Because the SDS 92 is fully compatible with the complete line of SDS peripheral equipment, analog and digital modules, and instruments, total application-oriented systems can be built around it. Users are thus able to capitalize on all the benefits of a computer-centered data system. These include:

- Lower Initial Cost

A major cost factor in special-purpose systems is the over-all controlling and sequencing logic, which must be uniquely designed and fabricated for every different application. The computer-based approach minimizes such costs plus the need for associated hardware by utilizing a common central element--the computer--which is produced in quantity rather than on a one-of-a-kind basis.

- Flexibility

A special-purpose system can perform only those functions built into it at the time of its design. Any change usually necessitates redesign, additional hardware, and--more important--results in the unavailability of the device when modifications are incorporated. By contrast, a computer-based system has built-in flexibility. Simple or complex changes in function can generally be effected merely by revising the computer program. Since hardware is not affected, down time for modifications is not required.

- Lower Operating Cost

The computer-centered system also decreases operating costs. Manual intervention is reduced because the computer, through its stored program, can perform more functions than the equivalent special-purpose system. Set-up, often consists of simply entering a program into the computer, thus eliminating costly manual wiring and plugging procedures.

- Reduced Turn-Around Time

Most special-purpose data systems provide neither analysis nor reduction capability. Data is generally produced on magnetic tape, which is then sent to a large digital computer for analysis and reduction. Because the large computer is usually situated at a remote site, a delay is imposed between the time data

is available and meaningful answers are obtained. As a result, many applications require a costly "quick-look" system in addition to the basic system. The computer-based approach obviates this problem by providing data analysis and reduction capability at the test site as an inherent part of the basic data system.

- Improved Understanding

Frequently overlooked is the benefit arising from the integration of instrumentation, reduction, and analytic efforts. In noncomputer systems, three separate groups generally participate in a data system project: instrumentation, data reduction, and engineering. Each group views the program from its own discipline; consequently, perspective is lost. The computer-based approach integrates various disciplines into a unified effort based on common aims and objectives. This results in improved understanding, communication, and a more efficient total system.

- Reliability

Computer-based systems generally exhibit much greater reliability than their special-purpose counterparts. This is achieved primarily by standardizing the central controlling element. One-shot design is eliminated, which provides "debugged," well understood, and fully documented hardware.

This recital of the benefits derived through use of computer-based systems is not meant to suggest that the computer is the panacea for everyone's problems. When cost is of overriding importance, some systems are simply too small to justify the use of a computer. The choice of a computer-based system must be founded on specific considerations that include performance, cost reliability, and growth potential along with the aforementioned general benefits.

User needs are best satisfied by a supplier who commands all the resources to provide a total system. Hardware, including not only the computer and its required peripheral devices but also programming aids and modular digital and analog building blocks, must be coupled with knowledge of the problem, empathy with the user's requirements, and experience.

This precise combination of products, technology, and experience is offered by Scientific Data Systems as an inherent part of the standard SDS 92 computer systems.

2. THE SDS 92 TOTAL SYSTEMS APPROACH

THE COMPUTER

The SDS 92 is a low-cost, general purpose digital computer specifically designed for use as the central controlling element in data collection, reduction, distribution, and control systems. The entire design of the SDS 92 is based on the fact that differences in cost, reliability, and complexity between a small, high-speed, general purpose digital computer and a special purpose unit designed for a unique application are small. Further, the SDS 92 is designed to accommodate a broader spectrum of applications than are possible with other small-scale computers. The SDS 92 design satisfies all the requirements of a systems device: low cost, reliability, modularity, high speed, and problem-solving capacity.

A singularly important characteristic of the SDS 92 is the exclusive use of monolithic integrated silicon circuits throughout the logic. Truly representing the current state-of-the-art, the SDS 92 has inherent advantages in reliability, maintainability, and cost when compared to computers using older technologies. The use of monolithic integrated circuits, designed to stringent specifications that emphasize the elimination and rejection of noise, radically reduces the number of components within the machine. This reduction in components also decreases the number of soldered interconnections. By reducing component count and simplifying the manufacturing process, cost is minimized; and both reliability and maintainability are maximized.

Figure 1 illustrates the over-all configuration of the SDS 92 main frame and the various options that allow the precisely correct features to be combined in each particular system.

High-speed operation and problem-solving capacity are achieved within price constraints by balancing a powerful instruction processing unit and a high-speed memory. The SDS 92 is built around a 1.75-microsecond memory with a minimum size of 2048 words of 13 bits each. Large memories of 4096, 8192, 16,384, and 32,768 words, respectively, are available. Twelve bits are used for information and one as a parity or checking bit. The SDS 92 central processing unit provides a full repertoire of instructions, automatic indexing in no additional time, direct addressing of the entire 32,768-word maximum memory, indirect addressing, etc. In short, the SDS 92 provides all of the basic features found in much larger computers.

The user, therefore, obtains the true benefits of the SDS 92's high-speed memory. The extensive instruction set simplifies programming and reduces the total effort

and cost of implementing a specific application. Further, the extensive instruction set makes efficient use of memory; space and time are not wasted performing the elementary operations that are frequently not mechanized in machines of the SDS 92's price class.

The SDS 92's twin accumulators permit chains of arithmetic operations to be developed without an unnecessary amount of load and store instructions. One of these registers also serves as an index so that indices can be generated through arithmetic processes and then used directly. The availability of a true index register yields simpler and faster programs and, also, programs that require less memory space. The complete 32,768-word memory is directly addressable in every basic instruction. The instruction set of over 64 instructions includes--in addition to the normal arithmetic, load, and store instructions--very extensive Logical, Branch, and Compare operations. These are particularly important in data systems applications because the amount of arithmetic involved is relatively small in comparison with the required logic. For example, it is possible to perform a within-limits comparison in four instructions without destroying the number that is being tested. At the end of the comparison operations, therefore, the number is still available in the accumulator. Further operations can be performed immediately based on the results of the comparison operation. The instruction set also includes instructions that facilitate the use of extended precision operations so that a 24-bit sum or difference can be computed with just two instructions. Similarly, if the optional multiply and divide instructions are used, a 24-bit product is generated; and division uses a 24-bit dividend to give a 12-bit quotient and 12-bit remainder. Optional multiply and divide execution times are 8.75 and 22.75 microseconds, respectively.

The input/output system is probably the most important consideration in evaluating the performance of a system's computer. Three standard I/O systems and an optional one are provided with the SDS 92. The first operates on full words and provides for transmission of either a single word or a block of words. For example, up to 4096 words can be transmitted to external devices at the rate of 1.75 microseconds per word. The second I/O system permits up to 8192 external lines to be activated and up to 8192 external lines to be tested. This system therefore provides for the generation and testing of control functions. The third I/O system operates on six-bit characters and is intended for use with standard peripheral devices such as cards, magnetic tape, and paper tape. A 12-bit buffer automatically assembles and disassembles characters. The six-bit external character size is optionally expandable to 12 bits.

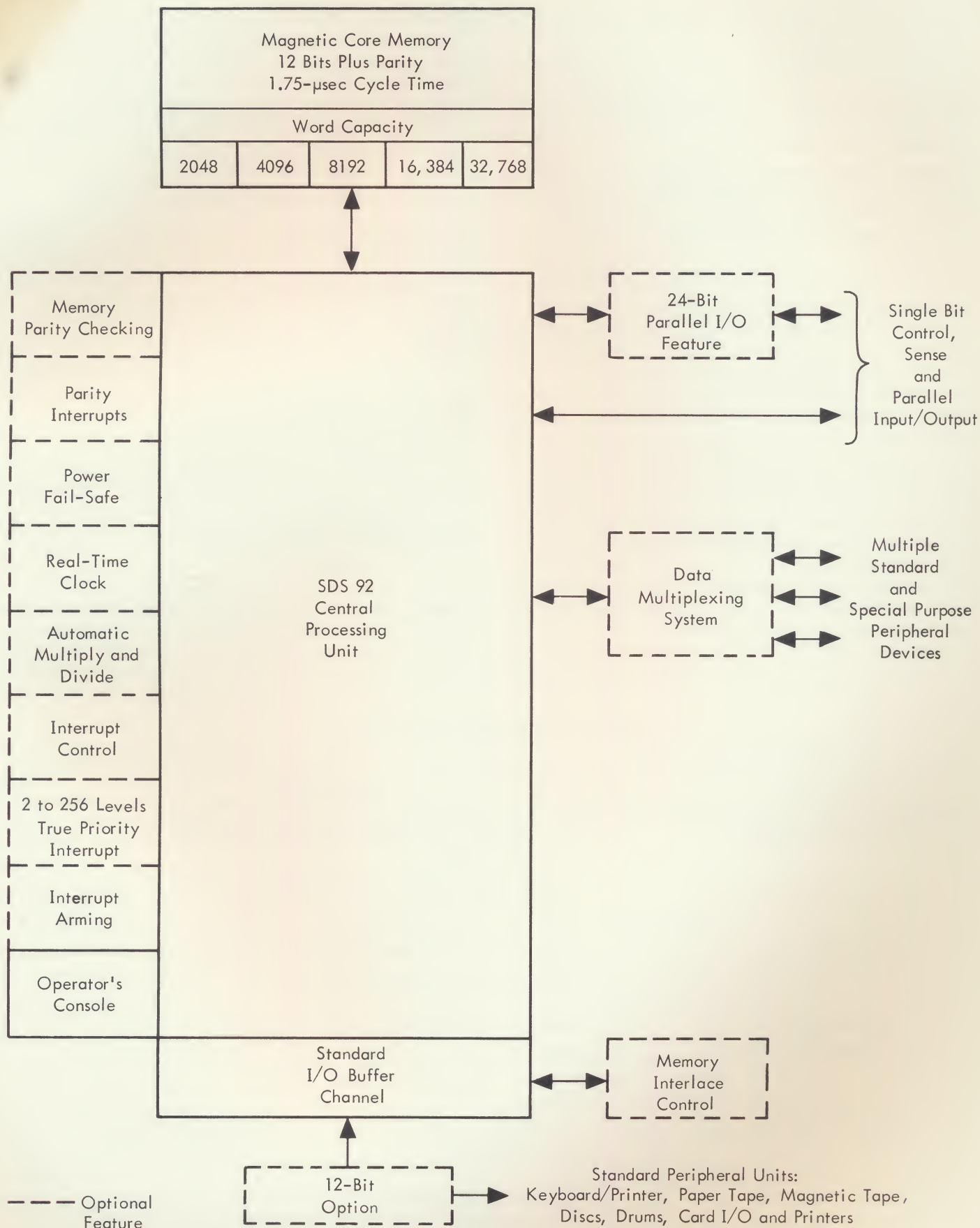


Figure 1. SDS 92 Computer Configuration.

Because these I/O systems need not involve the arithmetic portion of the computer, I/O and computation can proceed simultaneously. Further, no programming is required to store and reload the arithmetic registers for each I/O operation. An optional Data Multiplexing System permits the use of many I/O devices operating simultaneously and time-multiplexed with the central processor's access to memory. Availability of this system allows, for example, the simultaneous operation of two or three oscilloscope displays, magnetic tape units, or other data-recording devices.

The SDS 92, when used in system applications, generally operates in an environment in which its own I/O equipment and external devices interact asynchronously with the computer. The manner in which a computer is made to respond to such asynchronous stimuli can complicate programming and significantly reduce over-all efficiency. To avoid these problems, a comprehensive priority-interrupt system has been included in the SDS 92. Up to 256 levels of interrupt, arranged in a priority fashion, can be provided. Each interrupt level sends the computer program to a unique memory location when activated. The computer need not evaluate the proper response to a given external event; rather, the computer automatically goes to the beginning instruction of the response subroutine. Only 5.25 microseconds are required for the computer to initiate the response subroutine; and, further, none of the arithmetic registers of the computer are affected.

The interrupt system is a true priority system in that an interrupt of higher priority always takes precedence over an ongoing interrupt subroutine; whereas an interrupt of lower priority is deferred until the ongoing subroutine is completed. Interrupt subroutines are thus executed in an orderly manner but, at the same time, permit the computer to respond very quickly to any new higher priority interrupt condition.

PERIPHERAL EQUIPMENT

A complete line of peripheral units is available for the SDS 92 computer. These devices can be configured to give the computer any desired level or capability in such functional areas as operator and programmer communication, magnetic tape input and output, disc files and drums, line printer output, punched paper tape and punched card input and output. These SDS standard peripheral units use recording media that are fully compatible not only with other SDS units but also with virtually all modern computer systems. Data can be exchanged between the SDS 92 and almost all other computers without conversion or intervention.

Table 1 summarizes the principal characteristics of most standard SDS peripheral units.

Table 1. Standard SDS Peripheral Units

Device	Characteristics
Keyboard/Printers	IBM Selectric, 15 characters per second; available with 11- or 15-inch carriage Teletype Models 35AS and 35ASR offer outstanding reliability for high volume output.
Paper Tape (5-, 6-, and 7-level formats)	Readers--10 and 300 characters per second Punches--10 and 60 characters per second
Punched Cards (standard 80-column)	Readers--100-, 200-, 400-, and 800-card per minute models available to cover a complete range of throughput requirements Punches--100 and 300 cards per minute
Magnetic Tape Units	SDS MAGPAK stores 6 million six-bit (plus parity) characters on four logical units. Programming compatibility is retained with all other SDS magnetic tape systems. IBM-compatible format. Basic transport speeds of 75 and 120 inches per second. Systems are available with recording densities of 200, 200/556, or 200/556/800 bits per inch. Transfer rates are as high as 96,000 characters per second.

Table 1. Standard SDS Peripheral Units--continued

Device	Characteristics
Drums and Disc Files	Capacities from 32,000 to 67,000,000 characters. Transfer rates range from 41,700 to 120,000 characters per second. Average access times are as low as 8.5 msec. Expanded capacity and special performance units are available and quoted upon request.
Line Printers	Cover a broad range of performance. Strip Printer outputs 2400 lines per minute. Full 120- and 132-column units print at 140, 600, and 1000 lines per minute.
Plotters	Incremental, continuous form incremental plotter operates at 300 steps per second. X-Y and strip records available upon request.
Oscilloscope Displays	A complete set of plug-in modular elements allows the use of regular laboratory scopes or use of an SDS 21-inch CRT display. Provides for vector and character generator options and optional light-pen for man-machine interaction.
Communications	Full line of interface equipment for all common carrier and private line communication media.

Digital Modules and Analog Instruments

Scientific Data Systems has a complete line of digital modules and analog instruments. These serve as basic building blocks in special system hardware. In particular, they are the common elements that link the computer and its peripheral equipment to the analog, physical world. The same rigid adherence to conservative design criteria, noise rejection, compatibility, and reliability that characterize other SDS units is used in these devices. For example, silicon semiconductors are used exclusively. Further, the new SDS Digital-to-Analog and Analog-to-Digital converters use monolithic silicon integrated semiconductors.

Tables 2 and 3 briefly summarize the kinds of digital building blocks that are available from SDS. SDS digital modules and analog instruments cover operating frequency ranges from DC to 8 megacycles. All-silicon semiconductors provide reliability and wide temperature ranges; "hot-spots" need no longer pose design or environmental constraints. Refer to SDS 64-55-06A for a full description.

Table 2. SDS Digital Modules

Basic Circuit Type	No. of Different Types
Amplifiers, Inverters, Line Drivers	18
Clocks and Oscillators	6
Flip-Flops	13
Gating Circuits, Inverters	23
Special Purpose Modules (Shift Register, Schmitt Trigger, One-Shots, etc.)	5
Interface and Control Module (Delays, Transformer Coupler, Display Drivers, Interface, etc.)	17

Table 3. Analog Instruments and Assemblies

Basic Type	No. of Different Units	Characteristics
Amplifiers	7	DC, AC, Power, Sample and Hold; Voltage and Current Input Operational
Regulators	3	Wide range of precision characteristics permits the most economical choice for each application.
Digital-to-Analog Converters	7	From eight bits plus sign to 14 bits plus sign. DX15, DX16, DX17 modules include new SDS integrated circuit flip-flops.
Analog-to-Digital Converters	6	Both binary and BCD converters are available. Model AD30-12 converts (.035%) in 23 microseconds.
Multiplexers and Sample/Hold	-	Complete assemblies for 16 to 256 channels are available in both single-ended and differential input configurations.

3. STANDARD SDS 92 COMPUTER-CONTROLLED SYSTEMS

Given a computer with the general power and performance of the SDS 92 and its supporting peripheral equipment, digital modules, and analog instruments, high capability data and control systems can be implemented at a very low hardware cost. Traditionally, suppliers design these elements into a "one-shot" approach system. Although this approach brings many of the benefits of a computer-based operation, it requires engineering design, special fabrication, and check-out, which are both costly and lack standardization.

The costs associated with the one-of-a-kind philosophy can be eliminated if standard groupings of digital and analog hardware elements can be organized in a configuration suitable for a variety of applications. Because the computer's program, rather than system hardware, governs system operation, the hardware can be considered separately. In essence, a set of programs can parameterize a common set of hardware to perform totally different functional operations. Therefore, standard sets of hardware can be built to satisfy very broad classes of applications.

This section presents seven standard SDS hardware systems for various data and control functions. All are based on the SDS 92 computer and utilize SDS peripheral equipment, digital modules, and analog building blocks. They cover broad application areas and offer total systems capability at costs far less than either special-purpose devices or other computer-based systems.

- The Model SLE 1 Data Scanner/Logger scans 100 low-level inputs and performs limit checking, alarming, conversion to engineering units, and periodic display for any or all inputs. Typical applications include environmental testing, process monitoring, and permanent record recording.
- The Model DDE 1 Direct Digital Control System is designed for process control operations. The capacity of the SDS 92 allows the monitoring of 256 loops and full capability for optimization calculations.
- The Model SFE 1 Seismic Data Formatting System processes 24 channels of analog input and records outputs in either TIAC or IBM format magnetic tapes. This complete system also performs TIAC-IBM, IBM-TIAC, IBM-analog, and TIAC-analog conversions.
- The Model MSE 1 Message Switching System offers full store-and-forward capability for written message systems with as few as three circuits at a price

comparable to manual or electromechanical methods. The MSE 1 has built-in capability to handle up to 12 output circuits.

- The Model DCE 5 Data Collection System scans analog data, converts the data to digital form, and records the data on IBM-compatible magnetic tape. It is suited for remote field operation in data acquisition and recording applications of all types.
- The Model HCE 1 Hybrid Controller is a digital input/output and over-all mode control unit for modern general purpose analog computers. It is less costly than equivalent special purpose units. The HCE 1 can be expanded into a hybrid computing element by the plug-in addition of SDS analog/digital conversion units.
- The Model DEE 9 Digital Events Evaluator monitors and logs the status of multiple on-off events. Recorded data reflects the time and direction of each event. The sequence of events can also be checked against a prestored sequence table to provide automatic checking in applications such as missile check-out and testing processes of all kinds.

SLE 1 DATA SCANNER/LOGGER

SLE 1 Description

The Model SLE 1 Data Scanner/Logger, figure 2, is a high-performance data collection and monitoring system. It is specifically designed for a wide variety of applications including environmental testing, process monitoring, and signal analysis. Because the SLE 1 contains a general purpose digital computer, this device can be used for several separate purposes. By changing the computer's program, entirely different scanning sequences, different variables, and different conversion parameters can be accommodated.

The SLE 1 provides for terminating and multiplexing 100-millivolt range signals (typically provided by thermocouples, strain gages, etc.). These inputs are scanned at a rate of 30 per second, in a sequence determined by the computer, then digitized and entered into the computer. Each input is checked for high and low limits and optionally compared to a superhigh or "scram" limit. Data from any or all channels can be converted to engineering units and displayed in numeric visual or hard copy form.

Additional functions provided by programming are rate-of-change limit checks and periodic printout of logs.

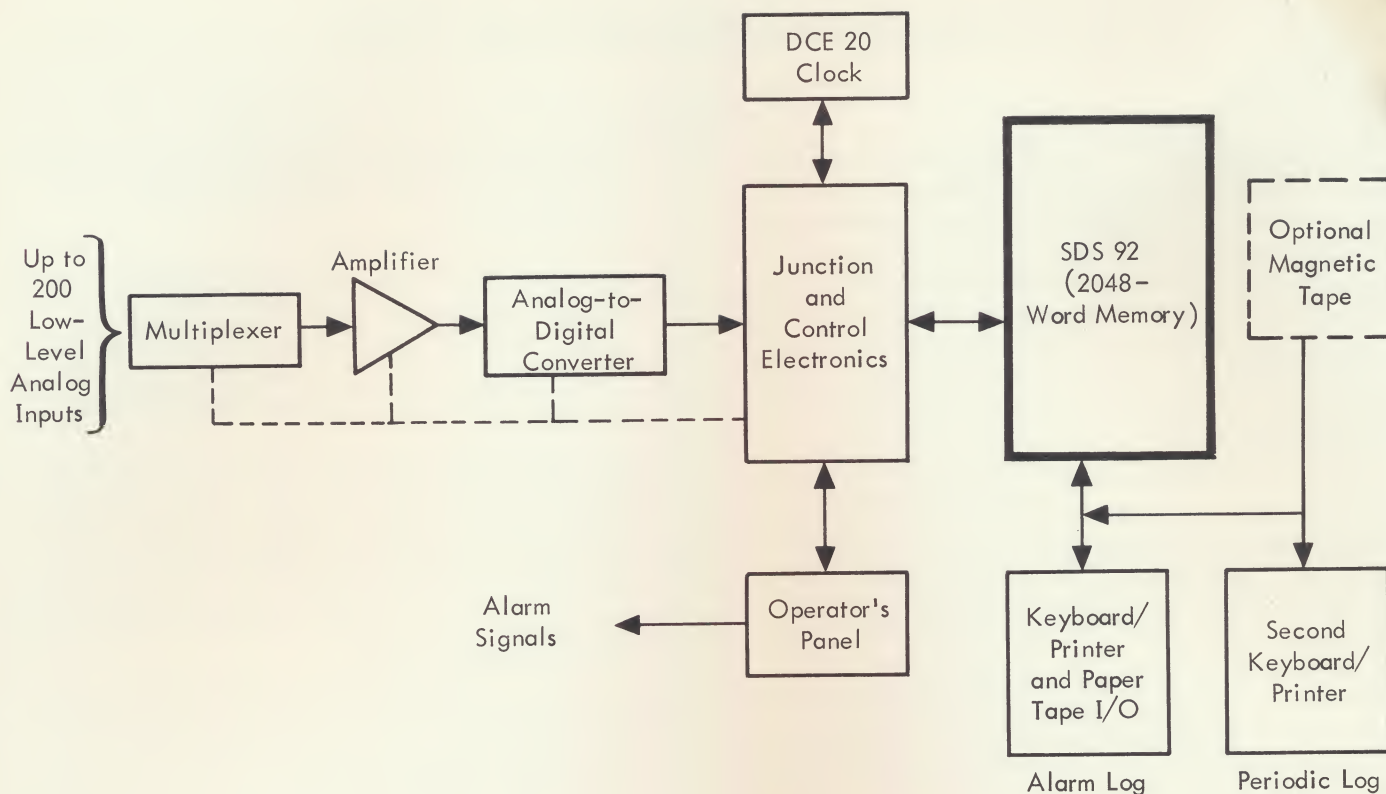


Figure 2. SLE 1 Data Scanner/Logger

The addition of a single SDS magnetic tape unit or of an SDS MAGPAK converts the SLE 1 into a low-level data collection system.

An operator's panel on the SLE 1 provides visual display of time, selected channel identification, and value and includes channel selector switches and alarm lights. Relay contact closures suitable for operating alarm lights and warning bells or horns are also included.

SLE 1 Specifications

Input and Multiplexer

Up to 100 low-level analog signals; optionally expandable to 200 channels. Multiplexer scanning sequence is computer-controlled.

Amplifier

Differential low-level amplifier with computer selectable gain.

Analog-to-Digital Converter

Model AD30-12, 11 bits plus sign. Accurate to 0.035 percent plus or minus 1/2 least significant bit.

Computer

SDS 92 with 2048 words of core storage.

Keyboard/Printer

One Model 9334 including paper tape reader and paper tape punch and one Model 9237.

Output

All out-of-limit channels and the time at which they went out of and returned within limits are logged. The additional keyboard/printer is used for hard copy printout of all channels at selected intervals.

Operator's Panel

Three switches to specify a channel. Three-digit channel number display. Four-digit value register. Four indicator lights (below, within, above, and scram limits). Two relay contact closures.

Clock

Model DCE 20 provides visual and program-readable time of day and a one pulse per second interrupt signal to the computer.

DDE 1 DIRECT DIGITAL CONTROL SYSTEM

Most process control systems utilize costly, special purpose equipment for the basic monitor and control operations. These devices are generally inflexible.

When the basic process is changed, the control equipment is also changed. Further, process optimization is frequently difficult to implement.

Direct digital control solves these problems. A system using a digital computer is flexible. Changing the program can cause a completely different process or control algorithm to be performed. Optimization calculations can be changed at will, allowing the precise choice of method and its implementation in each distinct application.

DDE 1 Description

The Model DDE 1 Direct Digital Control System, figure 3, is a completely unitized assembly of standard SDS products designed for all types of process control and process optimization applications. This system has equipment configuration and the processing power suitable for Type II and Type III direct digital control system. Basic functions include:

1. Input scanning
2. Alarm comparison
3. Control calculations using methods such as reset, proportional, ratio, and cascade
4. Generation of valve actuation output signals
5. Visual and hard-copy input and output in engineering units
6. Log sheet output
7. Optimization calculations (Type III)

The DDE 1 has 32 analog inputs (expandable to 256) and 16 digital output trunks suitable for operating stepping motors for valve positioning. Single-bit outputs, in the form of relay contact closures, are also included in addition to an operator's control panel.

DDE 1 Specifications

Input

Plus or minus 1 volt full scale into an amplifier with an input impedance of 10,000 ohms. (Optional pre-amplifiers are available.)

Scanner

Selects and switches 32 analog inputs at rate exceeding 30,000 samples per second.

Analog-to-Digital Converter

Model AD30-12, 11 bits plus sign, accurate to 0.035 percent plus or minus 1/2 least significant bit.

Computer

SDS 92 with 4096 words of core storage, Model 9334 Keyboard/Printer, paper tape reader, and paper tape punch.

Operator's Console

Contains visual display of selected channel identification and value, selection switches, a time-of-day clock (Model DCE-20), and watchdog timer.

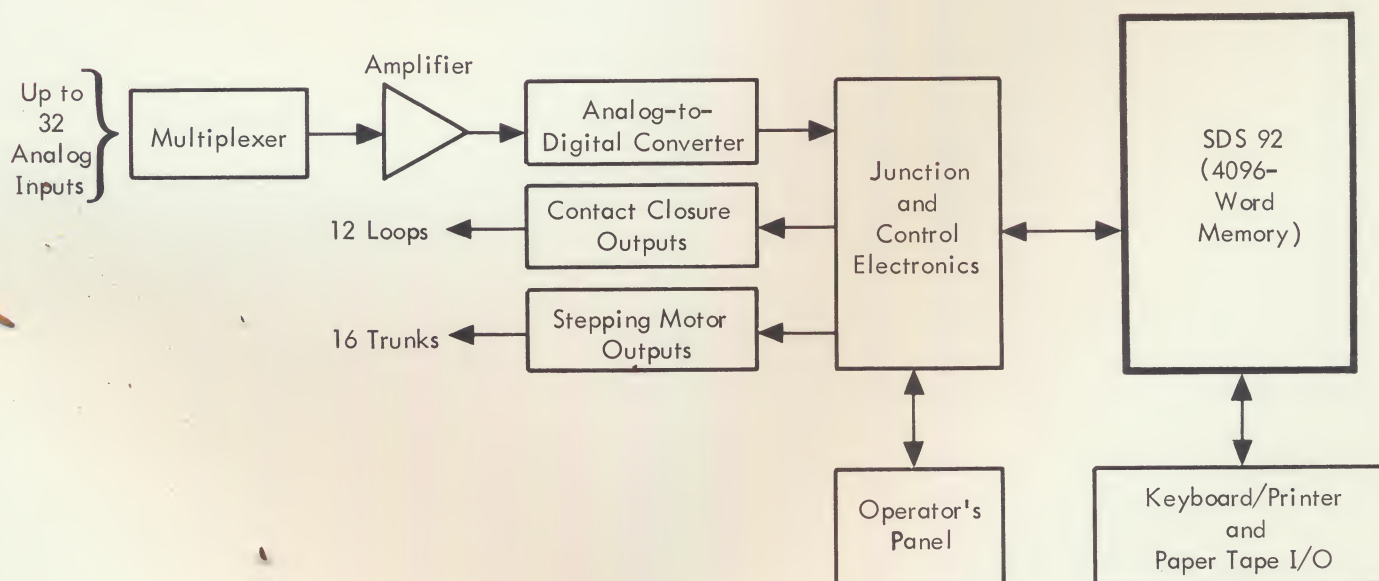


Figure 3. DDE 1 Direct Digital Control System

A high-speed, general purpose digital computer, the SDS 92 is designed for real-time systems control, direct digital control, message switching, formatting and peripheral processing, and repetitive, high-speed computation. The 92, which has

a basic price of only \$29,000, including console, Model 35 Teletype Keyboard/Printer, and 2048 words of memory, is comparable in speed, flexibility, ease of programming, and instruction set with medium-scale computers costing much more.



Digital Inputs

Provision for gating 12 on-off digital signals (0 and plus 8 volts) into the computer. Typically used to monitor relay contact closures.

Digital Outputs

Twelve computer-controlled relay contact closures.

Stepping Motor Outputs

Sixteen two-wire trunks. In each trunk one wire is used to wire the motor in a forward direction. The other wire is used to drive the motor in a reverse direction. One of three stepping rates can be specified separately for each motor.

SFE 1 SEISMIC DATA FORMATTING SYSTEM

The analysis and reduction of geophysical data typify the sophisticated exploratory methodology being practiced today. The proper interpretation of seismic data is the key to the location of oil and mineral deposits. In the past, seismic records have been formatted, correlated, and edited by special purpose devices. These units have two major limitations: (1) They require a large amount of manual setup and intervention, and (2) They are constrained to perform only certain functions or operations. Any change in the basic data reduction approach generally requires a costly and time-consuming rework of the equipment.

The SDS Model SFE 1 Seismic Data Formatting System rectifies these limitations. The computer can monitor its own environment, automatically change multiplexer scanning sequences, route data among different input and output devices (both during one run or between runs). Because the computer's activity is controlled by a program, data formats and reduction techniques are easily changed without the expense of redesign and rewiring.

Because the SFE 1 operates automatically, the need for intervention is considerably reduced over that required by fixed purpose units. An immediate benefit is that the computer-controlled system processes more data in a given time interval than its special-purpose counterpart. Valuable lead time, in terms of finding records of greatest interest at the earliest possible moment, allows exploration efforts to be directed to the areas of highest potential.

SFE 1 Description

The Model SFE 1 Seismic Data Formatting System, figure 4, performs three major functions: (1) conversion of analog data to gapped, IBM-compatible magnetic tape; (2) conversion of 1-inch, TIAC format 21-track digital magnetic tape into gapped, IBM-compatible magnetic tape; and (3) conversion of digital input to analog form suitable for oscilloscopic or chart recording and inspection.

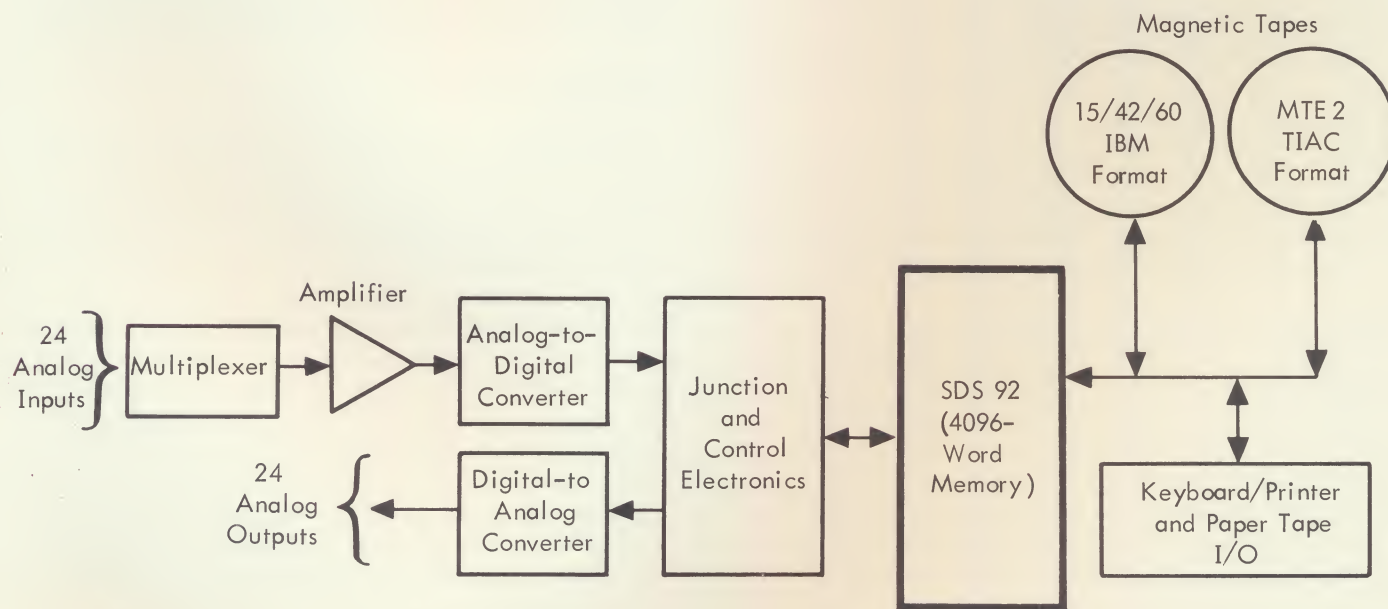


Figure 4. SFE 1 Seismic Data Formatting System

When converting from analog inputs to magnetic tape, 24 channels of analog data are multiplexed, digitized into 12-bit binary representation, and recorded in IBM-compatible, gapped magnetic tape. The output tape can be recorded at any of the three IBM standard densities: 200, 556, or 800 bits per inch. The process is continuous over the duration of recording (the SDS 92 computer acts as a buffer), and the sampling rate is variable.

Conversion from TIAC to IBM format tapes proceeds on a block-by-block basis. Successive TIAC records are located on the MTE 2 magnetic tape unit and read into the computer's magnetic core memory, using data from 18 of the 21 tracks. (The three channels not entered into the computer contain timing and synchronizing information used by the MTE 1's tape control section.) The process is repeated on a block-by-block basis until all records have been processed. The SDS 92 computer can inspect, correlate, time-shift, and bias records as they pass through.

When the SFE 1 is operating in the analog output mode, successive input records are read from either the TIAC or IBM-compatible units. Up to 24 channels of analog output data are presented simultaneously, at a rate that is specified externally. Analog outputs can be used to drive visual or hard-copy display or recording units, such as strip chart recorders. The operation is continuous over the recording interval; i. e., no time delays are incurred while reading successive input records from magnetic tape.

Other possible operating modes can be implemented on the SFE 1. For example, analog outputs can be generated in parallel with analog-to-digital or digital-to-digital recording and formatting.

SFE 1 Specifications

Analog Input

Twenty-four channels, plus or minus 10 volts into an input impedance of 10,000 ohms.

Frame Sampling Rate

Variable up to 1000 frames, of 24 variables each, per second.

Digital Input

Model MTE 2 magnetic tape unit and controller. Reads 21 magnetic tape channel gaps at 30 or 60 inches per second, 356 bits per inch density.

Computer

SDS 92 with 4096 words of magnetic core memory, Memory Interlace Control Unit, four levels of priority interrupt, Model 9334 Keyboard/Printer, paper tape reader and paper tape punch unit.

Digital Output (IBM format)

Model 92482/92462 Magnetic Tape Controller and Tape Transport. Reads and writes IBM format magnetic tapes, 75 inches per second at either of three densities: 200, 556, or 800 bits per inch.

Digital Output (TIAC format)

Uses Model MTE 2 described above.

Analog Output

Twenty-four channels, eight bits plus sign. Output is 10 milliamperes at plus or minus 10 volts.

MSE 1 MESSAGE SWITCHING SYSTEM

Written message communication systems generally employ either manual or electromechanical methods for routing data among remote locations. These systems are costly in terms of both initial investment and daily operation, and their complexity and rigidity generally restrict growth. Computer-based message switching systems have been practical for a large number of lines but not for relatively small systems.

For the first time, the small computer-controlled message switching system is practical in terms of both cost and reliability. The MSE 1 Message Switching System, figure 5, uses several SDS innovations to achieve economically reasonable message switching systems with from three to 12 circuits. The specific SDS units that can form this type of system are the SDS 92 computer, SDS lines sampling communications equipment, and low-cost SDS mass memory storage devices.

MSE 1 Description

Using telegraphic grade facilities, the MSE 1 switches up to 12 input and 12 output communication lines. The system also has a complete store-and-forward capability and a large capacity memory for back-up and queuing purposes.

The 12 input and 12 output telegraph-grade communication circuits can be arranged in any combination of simplex, half-duplex, and full duplex. Using SDS line-sampling technique, the computer samples the input lines and, by programmed techniques, reconstructs the bit pattern received, assembles bits into characters, and assembles characters into messages for further processing. Expensive assembly/disassembly and recognition circuits are eliminated by performing these functions in the computer.

The MSE 1 typically performs these functions:

1. Assembly of incoming messages into blocks. Any encoding format can be used (five-level, six-level, eight-level, etc.)

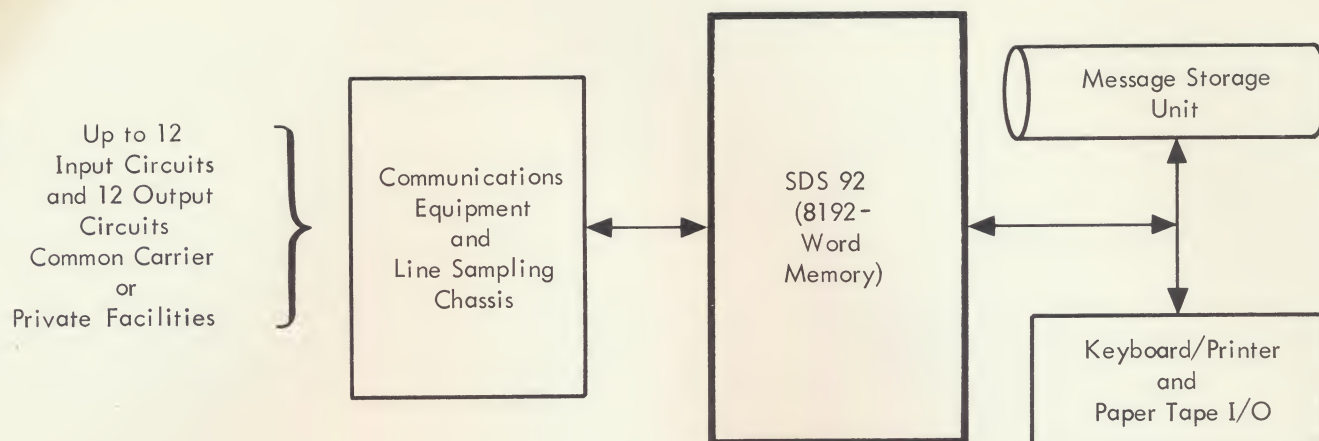


Figure 5. MSE 1 Message Switching System

2. Code conversion, which allows an intermixing of formats and teletype equipments.
3. Routing of messages to one or more locations.
4. Priority detection and allocation, which permit high priority messages to be handled immediately.
5. Queuing of messages for the availability of an output line.
6. Traffic analysis and statistical recording.
7. Operator display and control.

Messages are outputted by the computer by disassembling the text into characters and then into a bit-serial form for transmission.

MSE 1 Specifications

Communications Interface

Twelve input and 12 output circuits, adaptable to any common type and grade of communications service. Can be arranged in any combination of simplex input, simplex output, half-duplex, and full duplex

Computer

SDS 92 computer with 8192 words of core storage, all directly addressable. A Model 9334 Keyboard/Printer and paper tape reader/punch is provided for program preparation and loading, operator communication, and hard copy log recording.

Buffer Storage

Model 9161-1 Drum Memory System with 64,020 alphanumeric characters; 41,700 character/second transfer rate.

Auxiliary Units

SDS Line Sampling Chassis and SDS Communications Equipment Cabinet. Contains line relays, patching panel, indicator light, and meters to monitor and control the communication lines.

MODEL DCE 5 DATA COLLECTION SYSTEM

DCE 5 Description

The Model DCE 5 Data Collection System, figure 6, scans analog information at rates up to 16,000 samples per second, converts the data to binary digital form, and records this data on magnetic tape in a gapped record format. The magnetic tapes are recorded in the IBM 727-729 format. The recorded data is, therefore, compatible with all SDS computers and most computer systems in general use.

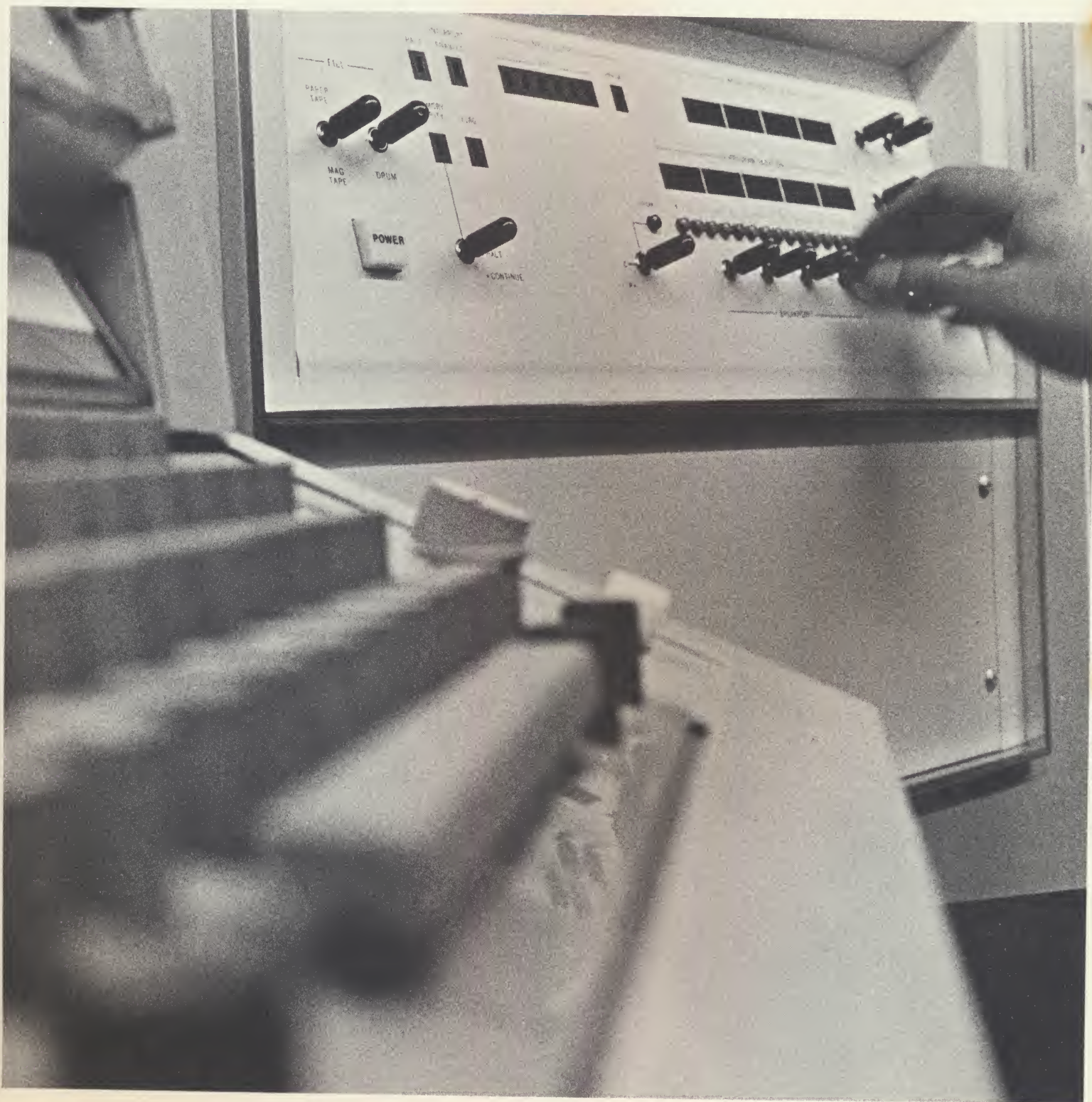
The DCE 5 can also utilize auxiliary SDS signal conditioning and calibration equipment. This allows the use of low-level inputs and computer-controlled calibration in addition to the high-level signal processing capability provided by the DCE 5.

The system contains an operator's control panel, which allows the convenient and rapid setup and monitoring of the data collection process. The operator can select the scanning rate and the number of channels to be sampled per scan. The sequence in which the inputs are scanned is programmed-controlled. This allows supercommutation and subcommutation so that individual inputs can be sampled at varying rates, depending on their frequency content. Thus, high-frequency data can be sampled more often than low-frequency data to prevent spectrum "folding" in the frequency domain.

In applications that do not utilize the maximum data throughput rate of 16,000 samples per second, the extra

The SDS 92 is the first commercial computer to use monolithic integrated circuits. One integrated circuit in the 92 replaces as many as 40 discrete components. This reduction in components also decreases the number of interconnections,

improving reliability at least three times over current equipment. Maintenance costs are also decreased. Not only are there fewer failures, but those that do occur can be corrected far less expensively.



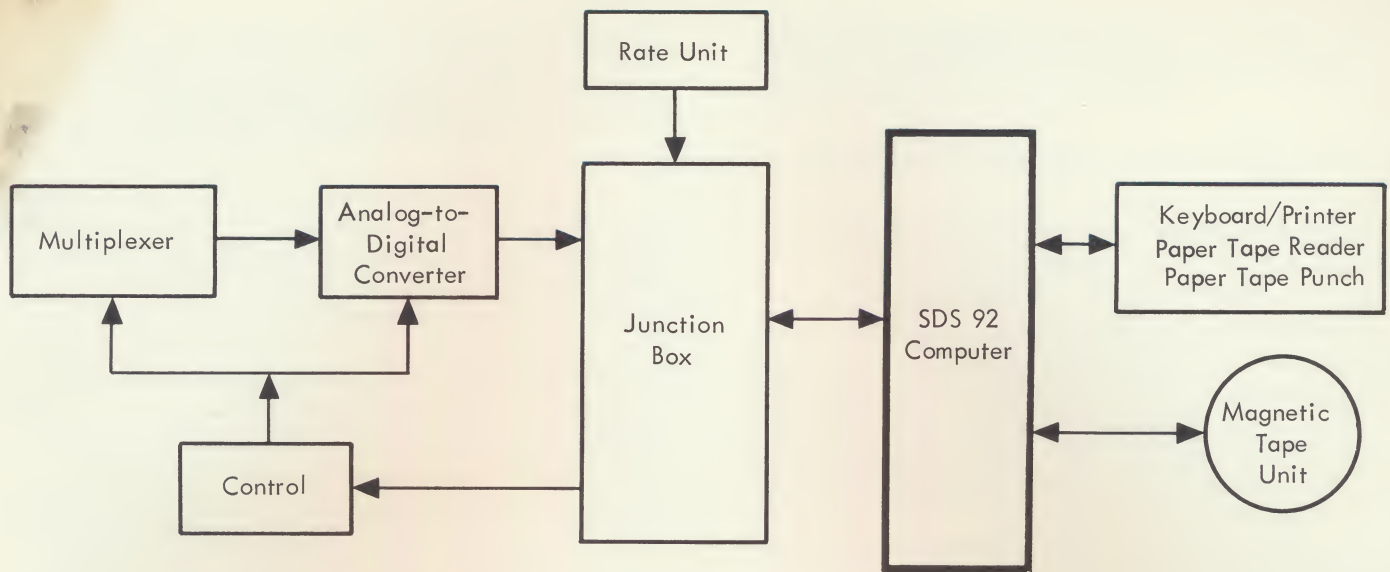


Figure 6. Model DCE 5 Data Collection System

capacity of the computer can be advantageously used for other purposes. Examples of the DCE 5's extra capability are high- and low-limit comparisons, conversion to engineering units, time averaging, and display of selected signals.

DCE5 Specifications

Input

Plus or minus 1 volt into 10,000 ohms; plus or minus 10 volts into 100,000 ohms; plus or minus 100 volts into 1,000,000 ohms.

Multiplexer

MU55 multiplexer and controls for 32 analog inputs. Prewired for add-on expansion to 256 channels. Model SX41 switches provide rapid settling times and overvoltage protection along with 0.01-percent over-all accuracy.

Analog-to-Digital Converter

Model AD30-12 Analog-to-Digital Converter, 11 bits plus sign. Contains a Model HX35 Sample and Hold Amplifier. The sampling uncertainty (aperture time) is less than 100 nanoseconds. Gain error is 0.02 percent and linearity 0.002 percent.

Sampling Rate

Model RCE 40 Rate Unit. Interrupt pulses, causing the computer to scan the analog inputs, are operator-selectable in increments of 50 microseconds over the range of 50 microseconds to 1 millisecond.

Computer

SDS 92 computer with 2048 words of magnetic core memory. Basic cycle time is 1.75 microseconds. A Model 9334 Keyboard/Printer with paper tape reader and paper tape punch is supplied for program preparation and loading.

Magnetic Tape Units

One Model 92482 Tape Controller and one Model 92462 Tape Unit. Tapes are read and recorded at 200/556 bits per inch in IBM-compatible format using either the binary or bcd mode. Maximum transfer rate is 41,700 six-bit characters (with parity) per second.

Accuracy

The total error is plus or minus 0.035 percent of the full-scale analog measurement, plus or minus 1/2 of the least significant bit.

Data Rates

The maximum instantaneous conversion rate is 44,000 samples per second. The over-all system throughput rate is 16,000 samples per second.

Expansion

1. One or more Model 92462 tape units can be added to accommodate uninterrupted data gathering over extended periods of time or to provide posttest data reduction capability.
2. SDS Signal Conditioning and Compumetric calibration assemblies are available as plug-in auxiliary units.

3. Computer memory and peripheral units can be added to give any desired processing capability.

MODEL HCE 1 HYBRID COMPUTER CONTROLLER

The manual operation and control of a general-purpose analog computer is a tedious and time-consuming process. Previously, special purpose devices have been employed to facilitate the operation of analog computers and to reduce problem set-up and check-out time. These devices--of which Beckman Instruments DO/IT and Electronic Associates ADIOS are typical--generally perform these functions: digital input, potentiometer set and readback, mode control, read-out and printing of analog variables, and comparison of analog variables to externally specified values. A digital computer not only can perform all these functions but its reserve capacity lets the user, in effect, enjoy the ancillary benefits of a second digital computing unit--all at a price comparable to that of an inflexible, fixed, special purpose analog computer controller.

HCE 1 Description

The Model HCE 1 Hybrid Computer Controller, figure 7, consists of a high-speed digital computer and a set of modular interface elements connected to an analog computer. The interface units are fully described in the SDS HI Series Hybrid Interface Equipment brochure, SDS 64-38-02B. The HCE 1 performs the functions of digital input, potentiometer set and verify, main mode control, read-back and hard-copy printout, and

comparison of analog variables to externally specified values. The HCE 1, therefore, has the capability of controlling and causing the analog computer to process a series of runs without manual intervention between each run.

Every HCE 1 operation is documented in hard copy form. Thus, historical records are available fully documenting (1) the parameters used as inputs to a particular run and (2) the final results obtained.

Because the HCE 1 uses a general purpose computer, man-machine communication is enhanced. For example, problem input variables can be expressed in physical units; and the computer can calculate or scale this physically meaningful data into the appropriate problem parameter such as a percent of full-scale potentiometer setting. Similarly, final solutions can be converted from their analog representation into physical units that are immediately meaningful to the engineer.

The Model HCE 1 is available with standard interface assemblies for the ADI-256, Beckman 2200, and Electronics Associates 231-R analog computers. The SDS HI Series of hybrid interface units are plug-compatible with the HCE 1 to expand the basic system into a full hybrid computer with analog-to-digital, digital-to-analog, and extensive digital computing capability.

HCE 1 Specifications

Digital Input and Output

Model 9334 Keyboard/Printer with paper tape reader and punch. Inputs are accepted from the keyboard or reader; outputs are printed and/or punched.

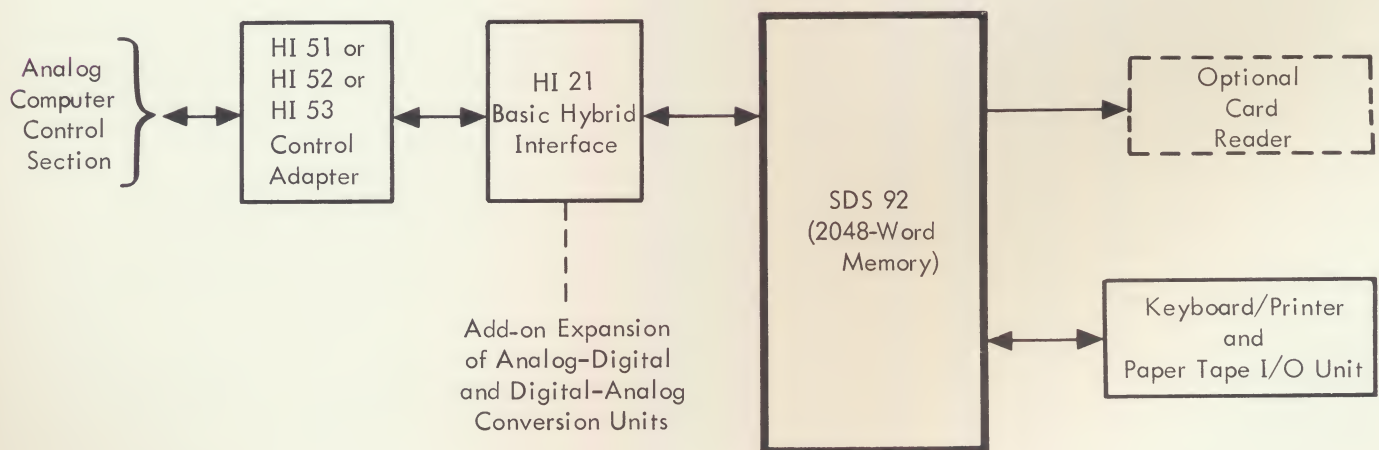


Figure 7. HCE 1 Hybrid Computer Controller

Computer

SDS 92 with 2048 words of core storage. Functionally expandable by modular addition of memory and automatic multiply/divide hardware.

Basic Linkage

Accommodates one analog computer adapter as described below. All signals between the digital computer and linkage equipment are transformer-coupled. The linkage equipment uses a separate power supply, which can be slaved to the analog computer reference.

Analog Computer Adapter

Three models are available. All provide signals of the proper duration and voltage level for the appropriate analog computer. Model HI 51 is used for Beckman Instruments 2200 Series Analog Computers. Model HI 52 is used with Electronic Associates 231-R computers. Model HI 53 is used with Applied Dynamics type AD 256 analog computers. Further details appear in the SDS 64-38-02B brochure.

DEE 9 DIGITAL EVENTS EVALUATOR

DEE 9 Description

The DEE 9 Digital Events Evaluator, figure 8, is a computer-controlled system that detects and records the ON-OFF status of a large number of digital input signals. Under control of a precision clock, the DEE 9 periodically scans all input lines at a high rate and detects any change-of-state by comparing the present state of each input line with the state of the line stored in the SDS 92 computer during the previous scan.

Each detected change is processed under program control and output to the I/O typewriter or paper tape punch. The output consists of the--

- Identity of the input line
- Present ON-OFF status of the input line
- Time at which the change occurred

An optional feature of the system is the facility for preparing a list of the predicted order in which input status changes will occur and then comparing the actual run-time order of status change with the predicted order. During this operation the system produces a chronological output of the status.

Input filters enable the DEE 9 to accept signals generated by relay contact closures. These filters discriminate against noise on both a time and amplitude basis. Noise pulse durations less than 1/2 millisecond are rejected. Inputs of less than plus 3 volts or open circuits are detected as the OFF state. Inputs of plus 8 volts to plus 28 volts are detected as the ON state.

Time resolution of the DEE 9 is a function of the number of input lines scanned and the peak number of changes that occur in a single scan. The operating characteristics for the basic DEE 9 system are shown in figure 9. Optional higher speed scanners, line printers, and magnetic tape recorders are available in expanded versions of the DEE 9.

DEE 9 Specifications

Inputs

192 to 1728 inputs; modular in groups of 192 lines

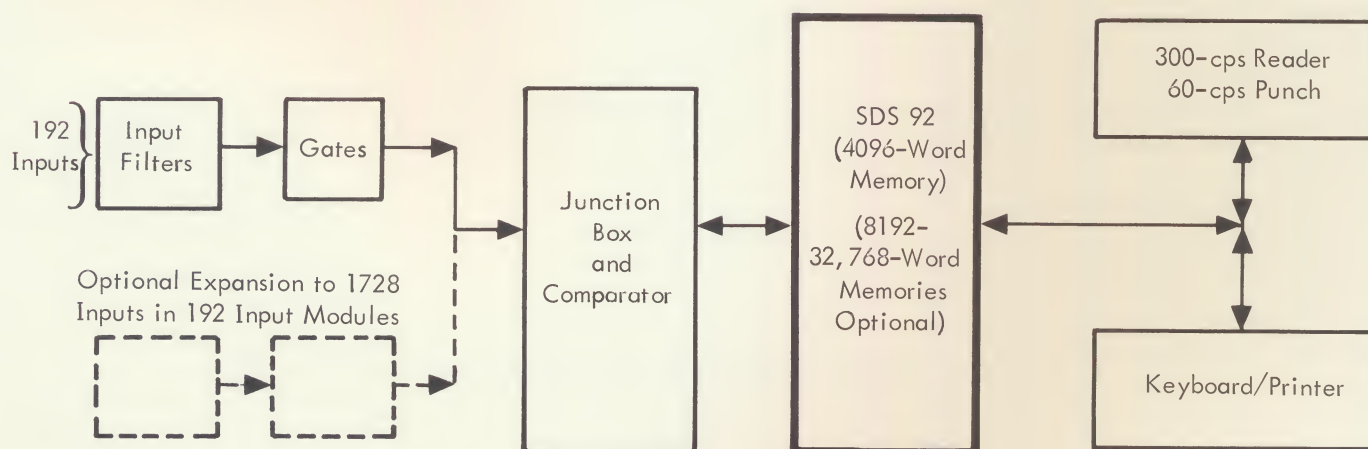


Figure 8. Basic DEE 9 Digital Events Evaluator

Input Level

0 volts and plus 8 volts into 3300 ohms

Capacity

See figure 9. Approximately 192,000 changes per second maximum rate

Time Resolution

Approximately 2 msec for 960 inputs

Computer

SDS 92 with 4096-word memory (8192 words required for more than 576 input lines). Model 9237 Keyboard/

Printer, 300-cps paper tape reader, and 60-cps paper tape punch.

Backlog Capacity

300 changes typical for 960 inputs and 8192-word memory

Output Speed

One-fourth change/2 seconds on typewriter; four changes/second on 60-cps paper tape punch. Optional: 40 changes/second with Model 9470 2400-lpm printer.

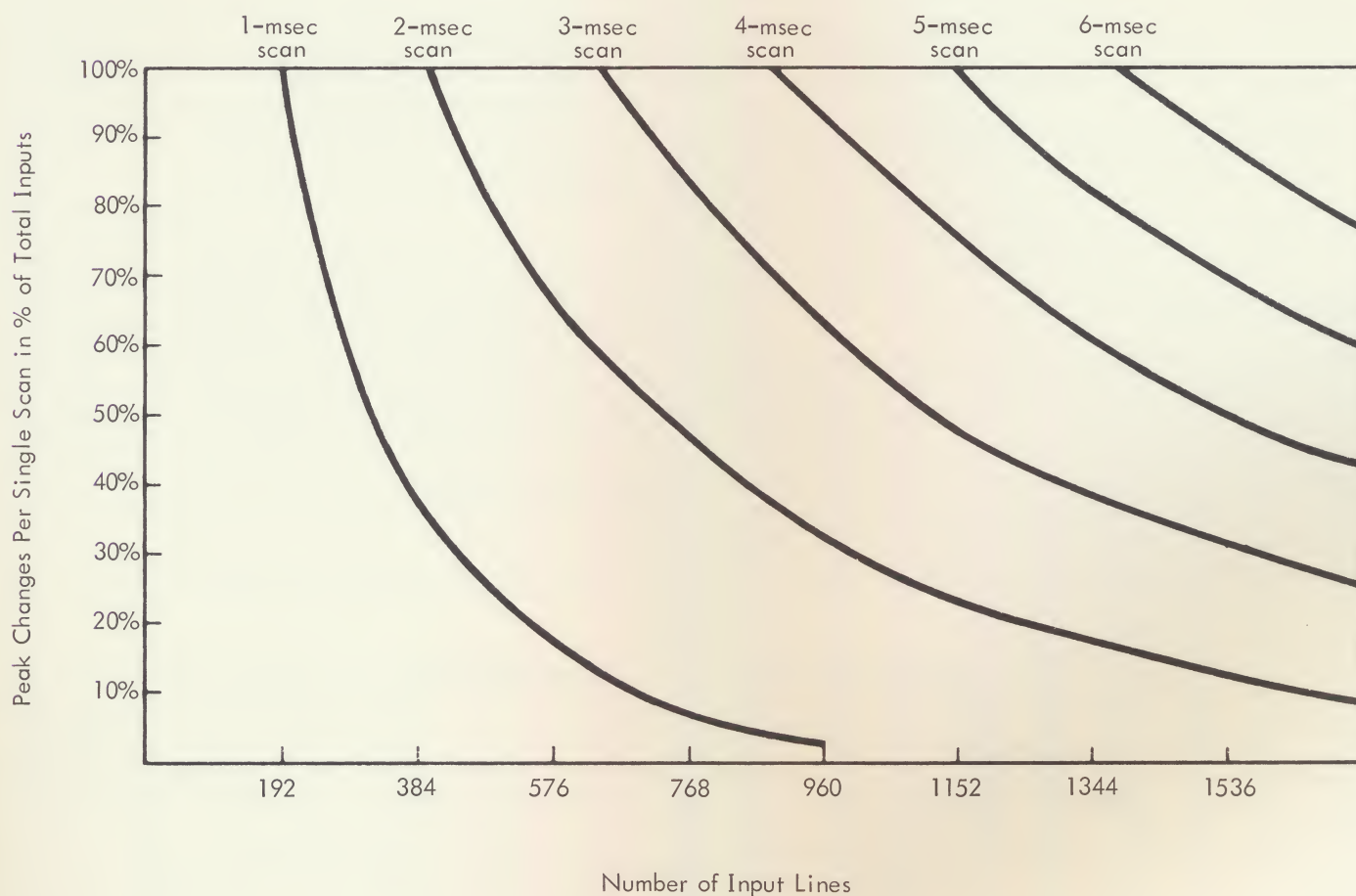


Figure 9. DEE 9 Operating Characteristics

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